TARGETING DEVICE FOR A LOCKING NAIL

BACKGROUND OF THE INVENTION

[0001] The invention relates to a targeting apparatus for a locking nail.

[0002] The targeting apparatus of the present invention is particularly suited for supracondylar nails. Such a nail is shown in U.S. Patent No. 6,010,505, the teachings of which are incorporated herein by reference. As is known, supracondylar nails are driven into the bony canal via the end of the distal femur. They serve for taking care of fractures in the condylar range of the femur. A nail of this type is designed as a locking nail, i.e. it is provided with cross-bores through which locking screws are passed to securely anchor the nail in the femur. A targeting apparatus is required to locate the cross-bores of a locking nail.

[0003] One type of targeting apparatus for locking nails is the one where the targeting apparatus is placed onto one end of the locking nail. Here, the targeting apparatus also serves as a hammering instrument to drive the nail into the femoral canal. On its target arm, the target apparatus has at least one target bore which is aligned with a bore in the nail shank. After the nail is knocked or hammered in, a hole is drilled into the bone via the target bore before the locking screws are threaded in. Such a targeting device is shown in U.S. Patent No. 6,039,739.

[0004] It is known for locking nails to have the cross-bores arranged at different angles and distances. It is further known to offset to axes of the cross-bores by predetermined angles in the circumferential direction of the nail. Furthermore, it is known to provide nails of different lengths with their cross-bores having different distances from the distal end. Unless particular provisions are made, a separate targeting apparatus would be required for each of the different nails. This results in an unacceptably large

number of targeting devices and related cost when a large number of such nails are provided.

SUMMARY OF THE INVENTION

[0005] Therefore, it is the object of the invention to provide a target apparatus for locking nails which enables the insertion of nails having different lengths and differently arranged cross-bores.

[0006] In the targeting device of the present invention, a holding device which joins the locking nail to the targeting apparatus has a reception bore which, in turn, receives a retaining bar. The retaining bar which is arranged in the reception bore extends nearly in parallel with a targeting arm in which there is at least one target bore. A target apparatus of this type is described in co-pending U.S. Application No. 10/391,896 filed on March 19, 2003. The retaining bar has recesses in the area in which it is located within the target bore. The recesses, for example, can be engaged by a locking pin which is movable radially to the axis of the reception bore. Thus, the pin locates both the axial position and rotational position of the retaining bar. The retaining bar has a coupling element for engaging the associated end of the locking nail. These commonly include a threaded pin which is screwed into the end of the nail, extends through the hollow retaining bar, and is subjected to a tensile stress by means of a nut at the other end in order that the nail and retaining pin be firmly pulled against each other. Moreover, interacting locating element of the nail and retaining pin locate a predetermined rotational position of these components with respect to each other.

[0007] The locking pin is actuated by a handle to optionally bring about an engagement with a recess or to unlock the locking pin. The position of the recesses in the retaining pin is such as to orient the target bore in the

target arm to a crossbore of the nail when the locking nail is in a recess.

[0008] A manufacturer of locking nails having different dimensions or different arrangements of the cross-bores will naturally produce only one set of such nails. This set is designed to cover all treatment cases that normally occur. Consequently, the retaining bar only needs to have the maximum number of recesses which match with the cross-bores of the individual nails of the set. Of course, it is also possible to provide a plurality of retaining bars which match with only certain locking nails.

[0009] According to the present invention, the handle has associated therewith, a device which signals whether the locking element or pin engages a recess. This allows the surgeon to recognize whether there is a predetermined connection between the target apparatus and the nail. This prevents any faulty operation.

[0010] An aspect of the invention provides that the handle is rotatably supported on a radial outer lug of a retaining portion exhibiting the reception bore. This handle is preferably defined by a rotary knob or the like. The handle actuates a radial portion which interacts with a cam surface in such a way that if the handle is rotated from an initial position in which the locking element is in its unlocking position the locking element is moved into the reception bore in one direction of rotation. The cam surface joining the unlocking position has a first cam surface portion which is joined by another cam surface portion. The engagement between the radial portion and the second cam surface takes place in a self-locking manner. The handle or radial portion is acted on by a spring in the direction of the unlocking position. Therefore, if the radial portion is in the first cam surface portion it will automatically move the handle back to the unlocking position when it is released while also

bringing the locking element into the release position. On the contrary, if the radial portion is in the second cam surface portion there is a self-locking situation and the locked position once set cannot release again by itself.

[0011] The function described has the following advantage. When the locking element is outside a recess of the retaining bar the handle can admittedly be rotated by a certain amount, but there is no success in moving the radial portion into the second cam surface portion. The result is that a leap back or spraying occurs to the unlocked position. This is what the surgeon can make out immediately. However, when the locking element gets into the recess, the radial portion can be moved into the second cam surface portion and, hence, remains in the locking position.

[0012] It is an advantage if the locking element is biased by a spring which makes it easier to discover a recess. An annular groove near the recesses also facilitates its discovery.

[0013] According to another aspect of the invention, the radial lug is annularly cylindrical and the cam surface portions are defined by at least one groove in the wall of the radial lug. The handle engages the groove by a radial portion. According to a further aspect of the invention, the radial portion can be defined by a cross-pin which radially extends through the lug and is preferably fixed to the two ends in the handle. Two equal grooves are required in the lug, for this purpose. At the same time, the cross-pin may extend through a cross-bore of the locking element to shift it in an axial direction.

[0014] Another aspect of the invention provides that the reception bore is formed in an annularly cylindrical component which is adapted to be located on the target arm by means of a radial outer tongue. For example, the targeting arm may be integrally formed from a suitable plastic material

or metal while the cylindrical component with the tongue is made of a different metal.

[0015] According to a further aspect of the invention, the cylindrical component has at least one window through which the retaining bar can be seen. The retaining bar can have placed thereon numbers or the like which appear in the window when the retaining bar has been located in a certain position.

[0016] These and other objects of the invention are provided for in a targeting apparatus for a locking nail of the type having cross-bores, the axes of which are disposed in an offset relationship from each other with respect to the longitudinal axis of the nail. The angular offset may either be in a circumferential plane or in a proximal/distal plane with respect to the nail axis and the cross-bores may also be spaced in the proximal/distal direction. The targeting apparatus has at least one screw target bore and a reception bore for a holding device to retain a first end of the nail. The reception bore is provided in which a retaining bar is guided, which bar extends parallel to the targeting arm. The retaining bar has a fastener to fix the nail to an adjacent end of the bore. The retaining bar has several recesses in the area of the reception bore and the reception bore includes a moveable locking element which can be caused to engage one of the recesses in the bar by use of a handle. The locking element locates and fixes the axial and rotational positions of the retaining bar in the reception bore. The recesses are arranged such that the target bore in the targeting arm is aligned with a cross-bore of the nail and the locking element engages a recess. The handle includes a spring loaded knob for indicating whether the locking element is in engagement with the recess or is out of engagement therewith. While, in the preferred embodiment, a spring loaded knob is utilized, any structure which signals

the positive engagement between the locking element, such as a pin, and the recess, can be utilized.

[0017] Preferably, the handle is rotatably supported on a radially extended outer lug or tube of a retaining portion including the reception bore. The handle actuates a radial portion or pin which engages with a cam surface on the lug such that if the handle is rotated from an initial position in which the locking element is in its unlocked position, the locking element is moved into the reception bore by a pre-determined direction of rotation of the handle. This is accomplished by a cam surface having a first cam surface portion joining the unlocked position and a second cam surface portion joining the first cam surface portion. Thus, the engagement of the radial portion and the second cam surface portion takes place in a self-locking manner and the handle or the radial portion is biased by a spring in the direction of the unlocked position. As indicated, the radial lug can be tubular and is preferably annularly cylindrical and the cam surfaces are defined by a groove in the lug or tube wall and the radial portion connected to the handle preferably is a pin or cam follower engaging the groove. In the preferred embodiment, the locking pin has an axial bore in which in a helical spring is arranged having one end supported on the cross-bore. The cross-pin extends through a cross-bore of the locking pin. The reception bore is defined by an annularly cylindrical component which is adapted to be located in a recess of the targeting arm by means of a radial outer tongue but can be affixed to the targeting arm by any convenient manner. In the preferred embodiment, the retaining bore has at least one window through which the retaining bar can be seen. In the preferred embodiment, the reception bore includes angled flats or prismatic surfaces which are mounted within the bore or on the side opposite the locking element and against which the retaining bar is

pressed by the locking element. In the preferred embodiment, the recesses in the retaining bar include annular grooves by which the locking element can be brought into engagement with the recesses.

[0018] The targeting arm has at least one guide bore alignable with a cross-bore for guiding a drill for inserting a cross-locking screw. The arm has a bushing in the reception bore extending along an axis generally perpendicular to this reception bore axis. The targeting device includes a targeting arm positioning rod or bar rotatably and slidably mounted within a bore of the bushing with the rod fixedly mounted on an end of the intramedullary nail. The positioning rod includes a plurality of offset detents corresponding to the locations of the cross-bores of the nail. These detents are usually recesses formed on the outer circumference of the rod. A detent element is mounted on the bushing and is selectively moveable into and out of engagement with the recesses on the positioning rod upon axial and/or rotational movement of the rod with respect to the bushing aligning the recesses with the detent element and axial movement of the element. The spring biased detent element is axially moveable from a first position in the bushing bore wherein the detent element extends only partially into the bushing bore and into each detent recess to a second position in the bore in which the detent element extends fully into the recess. In order to accomplish this, the bushing has an actuator handle mounted on an outer circumferential surface thereof, which handle engages the detent element on the bushing. The handle has a pin which engages cam surfaces to axially move the detent element from the first position wherein the detent element is only in the partially inserted first position to the second position wherein the bushing is in the fully inserted second position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will be described in more detail below with reference to an embodiment shown in the drawings.

[0020] FIG. 1 is a perspective view of a targeting apparatus according to the invention;

[0021] FIG. 2 is a side view of the targeting apparatus of FIG. 1 with no retaining bar;

[0022] FIG. 3 is a longitudinal section through the component of FIG. 2;

[0023] FIG. 4 is an enlarged view of the encircled portion 4 of FIG. 3;

[0024] FIG. 5 is a side view of a component of the target apparatus of FIG. 3 in the direction of arrow 5;

[0025] FIG. 6 is a side view of the component of FIG. 5 in the direction of arrow 6;

[0026] FIG. 7 is a section through the representation of FIG. 6 taken along line 7-7; and

[0027] FIG. 8 is an angled view of a groove of the component of FIGS. 5 through 7.

DETAILED DESCRIPTION

[0028] Referring to FIGS. 1 through 3, there is shown the targeting apparatus of the present invention generally designated 10. Device 10 has a target arm 12. Arm 12 has a relatively thick, enlarged portion 14 and a resilient portion 16 which is separated by a slot from the larger portion 14. Both portions 12 and 14 are traversed by a targeting bore 18. The resilient portion 16 enables a pin or targeting sleeve to be introduced into the targeting bore 18 and to be located in a desired position. This principle is well known from U.S. Application No. 10/391,896 filed on March 19, 2003.

[0029] In the preferred embodiment, targeting arm 12 is connected to an angled retaining portion 20 at the end of which is mounted an annularly cylindrical portion 22. The

cylindrical portion 22 will be explained in more detail below with references to FIGS. 3-7.

[0030] The cylindrical portion 22 has a reception bore 24 in which a retaining bar 26 is received. The retaining bar 26 exhibits a first cylindrical portion 28 at the end of which an end of a locking nail, which is not shown, can be mounted in a manner which is not depicted in detail, as is illustrated in co-pending U.S. Application No. 10/391,896. The locking nail may be a supracondylar nail, for example. A larger-diameter cylindrical portion 30 of the retaining bar 26 extends through the reception bore 24 of the cylindrical component 22. In the preferred embodiment, at the other end of the retaining bar 26, a nut 32 is screwed onto a thread of a tension bar (not shown) and extends through a bore in the hollow retaining bar 26. The front end of the tension bar is shown at 34. End 34 of the tension bar is screwed into a female thread of the locking nail so as to allow it to be tensioned against the left-hand end of the retaining bar 28 in FIG. 1. A location device between the nail and retaining bar 26 also help locate the locking nail in its rotational position relative to the retaining bar 26.

[0031] The cylindrical portion 30 has disposed therein several spaced-apart recesses. One is shown at 36 in FIG. 1. It rests on an annular groove 27.

[0032] The cylindrical component 22 is shown in more detail in FIGS. 5 through 7. In the preferred embodiment, reception bore 24 is not strictly of a circularly cylindrical shape, but that straight surface portions or flats are formed in two positions at 40, 42. In a nearly diametrical opposition to these flat surface portions, the outside of component 22 has mounted thereon a sleeve portion 44 which extends into reception bore 24 via an aperture 46 in cylindrical component 22. As is further evident from FIGS. 5 through 7, the preferred sleeve portion 44 is cylindrical and

has two grooves 48 which are arranged in a diametrically opposed fashion. Grooves 48 are arranged so as to have one end thereof on diametrically opposite sides of sleeve 44. One end of a groove 48 is shown at 50 in FIG. 5. This portion is joined by a first groove portion 52 which is inclined towards element 22 at an angle relatively steep. Portion 52 is joined by a second groove portion 54 which is relatively flat or at a shallow angle with respect to the longitudinal axis 55 of sleeve 44. Such a groove is shown in FIG. 8 in an enlarged view. In the preferred embodiment, relatively steep groove portion 52 has an angle of ascent of about 35°. The groove portion 54, which is flatter and circumferentially longer, has an angle of ascent of about 5°.

[0033] In FIGS. 6 and 7, it is shown that component 22 has diametrically opposed windows 56, 58 the function of which will be referred to later.

[0034] It can be seen from FIG. 4 that a rotary knob 60 is rotatably supported on sleeve portion 44. Rotary knob 60 is diametrically traversed by a driver pin or cross-pin 62. Cross-pin 62 extends through grooves 48. Rotary knob 60 is in a differing axial position on sleeve portion 44, which depends on the rotated position of pin 62 in grooves 48.

[0035] Within sleeve portion 44, a locking pin 66 is slidably arranged in an axial direction. Pin 66 is hollow in its lower region as shown in FIG. 4. Furthermore, sleeve 44 has a cross-bore through which pin 62 extends. Locking pin 66 has an axial bore with a helical spring 68 placed therein. An enlarged locking portion 70 of pin 66 extends into the reception bore 24 through the aperture 46. FIG. 4 shows the position of locking pin 66 in which the locking portion 70 protrudes farthest radially into reception bore 24. Any further axial movement is limited by an outer shoulder of pin 66 (not shown) and bears on the border of aperture 46.

[0036] In the unlocked position of the arrangement described, cross-pin 62 is in the end regions of grooves 48 which are designated 50. Therefore, the locking pin 66 has a position lowered with respect to that of FIG. 4, but its portion 70 still slightly protrudes into reception bore 24. In this position, when reception bar 26 of FIG. 1 is introduced into the reception bore 24, locking portion 70 can snap into a recess 36 and lock bar 26 in position. If rotary knob 60 is then rotated locking portion 70 can completely engage recess 36. It is required to rotate rotary knob 60 so far that cross-pin 62 enters the groove portion 54. When pin 62 has reached portion 54, a self-locking situation occurs because the angle of the groove portion 54 is very small. This prevents an automatic return rotation of knob 60.

[0037] However, if locking pin 66 is actuated with the locking portion 70 not already having partly snapped into recess 36 a rotation of rotary knob 60 and, hence, a movement of locking pin 66 would cause the locking portion 68 to bear on the outer surface of the cylindrical portion 30 and not in recess 36. In this situation, cross-pin 62 can be moved only within the groove portion 52. It cannot get into portion 54. Thus, this causes rotary knob 60 to be automatically rotated back to the initial position because of the action of spring 68 when locking pin 66 does not engage a recess 36. This can be ascertained by the surgeon so that any faulty operation is precluded.

[0038] While retaining bar 26 is located in place in reception bore 24 a radial pressure is exerted on portion 30 of retaining bar 26 because of the movement of locking pin 66. As a result, it is pressed against the prismatic surfaces 40, 42 so that retaining bar 26 is safely located in place.

[0039] The surgeon may look into the reception bore 24 through a window 58 and make out whether a marking or number appears in window 58 from which he can deduce with which recess 36, locking pin 66 has been brought into engagement. Since each recess 36 matches with a certain cross-bore of the locking nail (not shown), the surgeon will also know with which locking bore the target bore 18 of target apparatus 10 is aligned.

[0040] For completeness, it should also be mentioned that a tongue 80 which is opposed to sleeve portion 44 is mounted on cylindrical component 22, which tongue is placed in a recess holding portion 20 of targeting-aiming apparatus 10 and is safely mounted within such as by pins or grooves.

[0041] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.